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Treatment effects of a Twin-Force Bite Corrector versus an Activator in comparison with an untreated Class II sample: a preliminary report

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Objectives: The present study aimed to compare the treatment outcomes of a fixed-functional appliance (Twin-Force Bite Corrector - TFBC) and a conventional removable functional appliance (Activator) in the treatment of skeletal Class II malocclusions.
Methods: The TFBC and Activator Groups each included 10 young adults possessing a skeletal Class II malocclusion, and the treatment outcomes of both groups were quantified and compared, using lateral cephalometric radiographs, with an untreated skeletal Class II Control Group.
Results: A skeletal Class I relationship and a marked reduction in overjet were achieved in both treatment groups; however, the duration of treatment was significantly shorter in the TFBC Group (0.45 years) when compared with the Activator Group (1.37 years) ($p < 0.001$). Effective length and sagittal positioning of the mandible underwent significant changes in the TFBC and Activator Groups. Vertical facial dimensions increased in each group; however, these increases were significantly greater in the Activator Group when compared to the TFBC and Control Groups ($p < 0.05$). Dentoalveolar changes also contributed to the reduction in overjet.
Conclusions: Although both appliances succeeded in eliminating the Class II relationship and improving the overjet and overbite, the short treatment time in the TFBC Group raises questions regarding the long-term stability of the results.
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Introduction

Successful growth alteration of the facial skeleton with functional orthopaedic appliances has been a matter of debate in the orthodontic literature for decades.[1-6] Much of the discussion surrounding Class II treatment centres on whether functional appliances are capable of achieving a permanent increase in mandibular length.[2,6,7]

Many types of functional appliances have been introduced in the search to find the most efficient design. Patient compliance is a critical factor which governs treatment success[5,8,9] and so there has been an increasing tendency towards the use of fixed-functional, rather than removable-functional, appliances. The Twin-Force Bite Corrector (TFBC) (Ortho Organizers CA, USA) system introduced by Rothenberg et al.[10] is a fixed, push-type intermaxillary appliance incorporating ball-and-socket joints, which permit a wide range of motion, lateral flexibility and full mandibular movement.

Publications on the effects of the Twin-Force Bite Corrector are limited and are mostly case studies.[10-14] A prospective clinical trial which investigated the effects of TFBC in comparison with an untreated control group[15] and another which compared TFBC effects in pre- and post-pubertal patients,[16] suggested increased treatment efficiency. The present study aimed to compare the treatment outcome of the TFBC with an Activator appliance and a control group of untreated skeletal Class II individuals.

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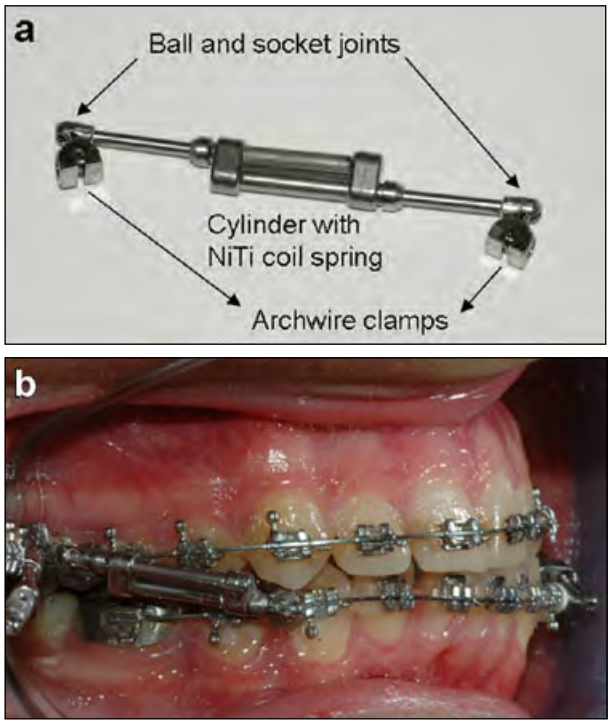


Figure 1. Twin Force Bite Corrector.

Subjects and methods

The study consisted of 30 skeletal Class II patients exhibiting mandibular retrognathism. Twenty patients, who were referred to the University of Ankara, Department of Orthodontics for orthodontic treatment, were randomly allocated into one of two treatment groups. Ten patients were treated with a TFBC (2 females, 8 males), while another 10 patients were treated with an Activator appliance (3 females, 7 males). The remaining patients served as an untreated control group whose lateral cephalometric radiographs were selected from the longitudinal archive of the University of Ankara. The control data (C Group; 4 females, 6 males) were collected between 1991 and 1996 and parents of all individuals agreed to participate and provided informed consent. Table I indicates the distribution of patients by chronological age at the start of treatment (T1) and at the end of mandibular growth stimulation/observation (T2), as well as the length of the treatment/observation periods.

The selection criteria were:

- a Class II malocclusion with a retrognathic, mandibular-deficient profile
- minor crowding
- no congenitally missing teeth and/or dental anomalies
- no prior history of orthodontic treatment
- a full permanent dentition since the TFBC is applied via fixed appliances.

Appliance design

Twin-Force Bite Corrector (TFBC)

The TFBC consisted of two telescopic systems with internal coil springs (Figure 1). The appliance is attached to maxillary and mandibular fixed appliance archwires and is screwed to the mesial of the maxillary molars and to the distal of the mandibular canines using a specialised, provided screwdriver. Roth preadjusted brackets with 0.018 x 0.025 inch slots were attached to the teeth. After the upper and lower arches were aligned, 0.017 x 0.025 inch rectangular stainless steel archwires were inserted with lower labial incisor root torque to minimise lower incisor proclination. In addition, the archwire distal to the molars was cinched back. To minimise upper incisor retroclination, palatal root torque was applied to the upper incisors. A transpalatal arch was not considered but has been used by others.[10-16] The TFBC was removed after three months and the occlusion checked for overcorrection into a super Class I.[10-16]

Activator

Each Activator was constructed with a 6-7 mm sagittal and 2-3 mm vertical activation. Patients were instructed to wear the activator at all times except while eating, drinking or engaging in sports. The incisal third of the mandibular incisors was capped with acrylic to minimise labial tipping. Once a Class I molar relationship had been achieved, the posterior lower occlusal acrylic was trimmed to allow lower molar eruption into the inter-occlusal space.

Cephalometric analysis

Cephalometric landmarks were marked and digitised using the PorDios (Purpose on Request Digitizer Input Output System, trademark of the Institute of Orthodontic Computer Science, Aarhus, Denmark) cephalometric analysis program. The vertical and horizontal reference planes were constructed based on the occlusal plane suggested by Pancherz,[1] which

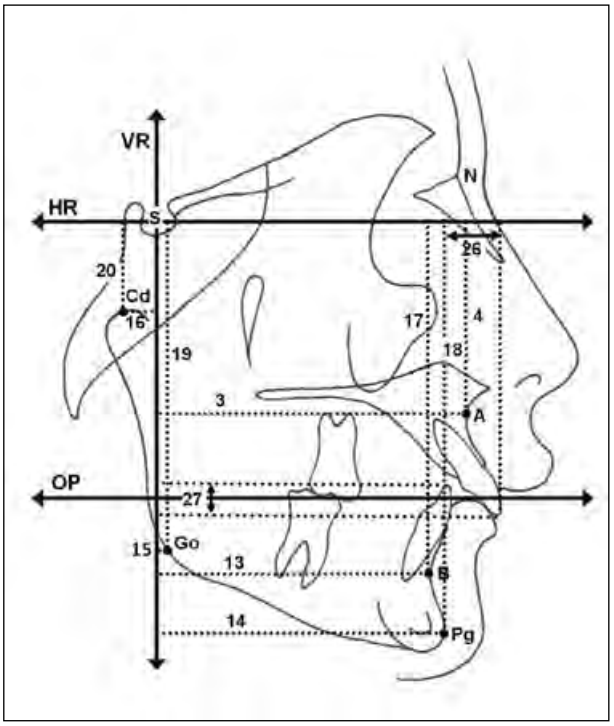


Figure 2. Reference plane measurements: 3, A-Vert; 4, A-Hor; 13, B-Vert; 14, Pog-Vert; 15, Go-Vert; 16, Cd-Vert; 17, B-Hor; 18, Pog-Hor; 19, Go-Hor; 20, Cd-Hor.

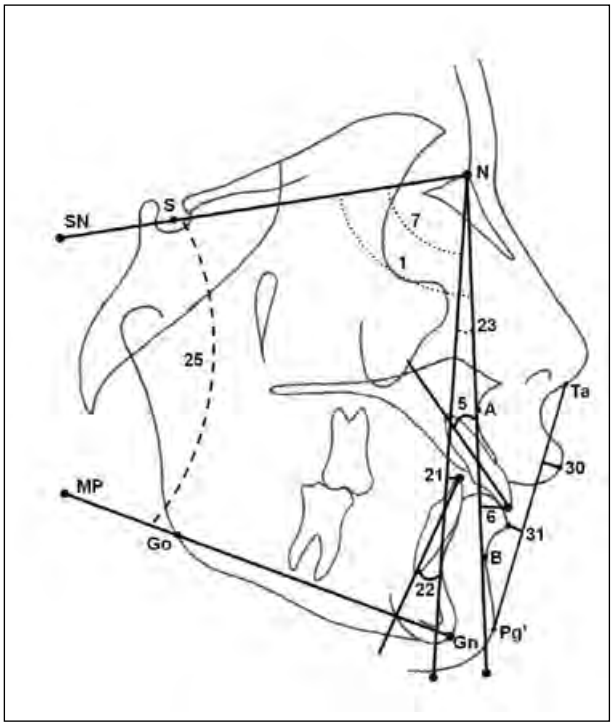


Figure 3. 1, SNA; 5, U1-NA (mm); 6, U1-NA (°); 7, SNB; 21, L1-NB (mm); 22, L1-NB (°); 23, ANB; 25, SN/MP; 30, UL-Steiner line; 31, LL-Steiner line.

bisected the incisal overbite and passed through the vertical midpoint of the distobuccal cusp tips of the first molars. A vertical reference plane (Vert) was constructed perpendicular to the occlusal plane and a horizontal reference plane (Hor) was constructed parallel to the occlusal plane, both of which passed through point sella (S) (Figure 2). The landmarks were transferred from the pretreatment to the post-treatment tracing by superimposing the radiographs on stable cranial base structures according to the method described by Björk and Skieler.[17] In total, 22 landmarks were digitised and 32 variables analysed (Figures 2-4).

Statistical analysis

Statistical analysis was performed using the Minitab statistical software package (Minitab Statistical Software Release 13 for Windows). Descriptive statistics were calculated (Table I), and the Student's and paired *t*-tests were performed to identify differences within and between groups (Table II). An Analysis of Variance (ANOVA) and Duncan's tests were used to compare cephalometric changes between groups (Table III). The cephalometric landmarks on radiographs were digitised twice simultaneously and the program (PorDios) automatically rejected the results if two digitised points identifying the same landmark did not co-incide.

Results

The comparison of the pretreatment mean values between groups at T1 is presented in Table II. The comparison of the cephalometric changes which occurred during the treatment/observation period is presented in Table III. Both the TFBC and Activator appliances were successful in eliminating the Class II relationship and in reducing the overjet and overbite by a combination of skeletal mandibular and maxillo-mandibular dentoalveolar changes. Treatment time was significantly shorter in the TFBC Group (0.45 years) compared with the Activator Group (1.37 years) ($p < 0.01$).

Maxillary skeletal and dentoalveolar structures

Point A in the Control Group moved downwards and forwards as a result of natural and unaffected growth.

Table I. Chronological age of patients at T1 (pretreatment/pre-observation) and T2 (post-treatment/post-observation), and treatment/observation durations.

	Chronological age						Treatment duration		
	T1			T2			T2-T1		
	X	Minimum	Maximum	X	Minimum	Maximum	X	Minimum	Maximum
TFBC	14.88	13.58	17.25	15.56	14.00	17.92	0.45	0.25	0.63
Activator	13.04	12.42	14.92	14.41	13.75	15.67	1.37	0.98	1.69
Control	13.66	12.67	14.92	14.73	13.92	15.92	1.06	0.97	1.18

Similar movement was also observed in the treatment groups. The only significant difference in maxillary measurements was the amount of maxillary incisor retraction seen between the Activator and the Control Groups ($p < 0.058$).

Mandibular skeletal and dentoalveolar structures

Effective mandibular length

The increase in mandibular length in the Activator Group was twice that of the TFBC and Control Groups ($p < 0.001$). Although the increase in mandibular length was similar in the TFBC and Control Groups, the observation periods were 0.45 and 1.06 years, respectively.

Sagittal position of the mandible

The sagittal position of the mandible in regards to the vertical plane (B-Vert and Pog-Vert) improved significantly in both treatment groups, but the increase in SNB was significant only in the Activator Group. However, no statistically significant differences were recorded between any of the groups.

Vertical position of the mandible

B-Hor, Pog-Hor and Go-Hor showed statistically significant increases within all groups. However when the groups were compared, the differences between the Activator versus TFBC and Activator versus Control Groups were significant. There was no statistically significant difference between the Control and TFBC Groups.

Mandibular dentoalveolar measurements

The mandibular incisors proclined significantly in the TFBC and Activator Groups.

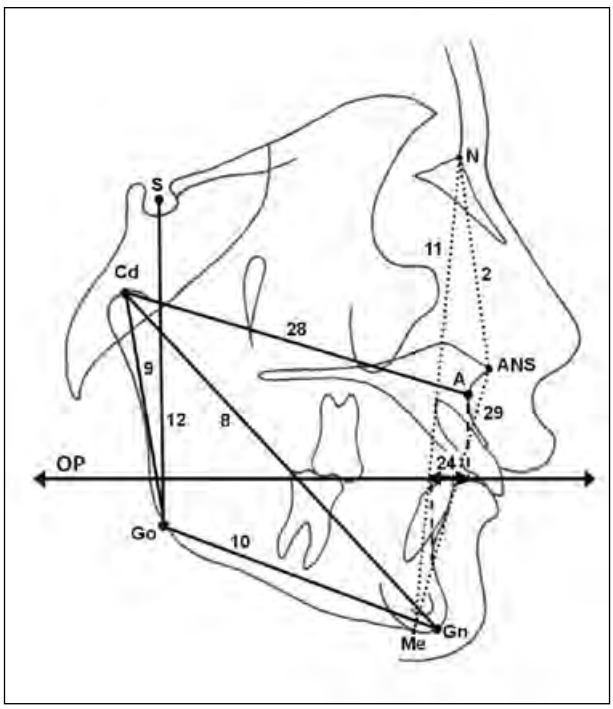


Figure 4. 2, N-ANS; 8, Cd-Gn; 9, Cd-Go; 10, Go-Gn; 11, N-Me; 12, S-Go; 24, Witts appraisal; 28, Cd-A; 29, ANS-Me.

Effects on facial heights

N-Me, ANS-Me and S-Go increased significantly in the Activator and Control Groups; however, statistically insignificant changes were seen in the TFBC Group. Increases in N-Me and S-Go were statistically significantly different between the Activator and TFBC Groups.

Maxillo-mandibular relationship

The decrease in ANB angle was similar and significant in both treatment groups ($p < 0.05$). The Wits Appraisal decreased significantly more in the TFBC Group compared with the Activator and Control Groups ($p < 0.01$). Reductions in overjet and overbite were statistically significant in the treatment groups

Table II. The comparison of the mean values of the dentoskeletal and soft tissue variables at T1 between groups, by Student *t*test.

Parameters	TFBC		Activator		Control		Test	TFBC-Activator	TFBC – Control	Activator-Control
	X	± SD	X	± SD	X	± SD				
Maxillary skeletal measurements										
1. SNA	81.6	3.25	79.7	3.97	81.5	3.25				
2. N-ANS	58.43	4.62	55.2	2.90	56.0	2.00				
3. A-Vert	80.6	4.41	73.0	3.21	77.2	4.72	***	***		
4. A-Hor	43.1	2.58	41.8	5.53	37.7	6.33				
Maxillary dentoalveolar measurements										
5. U1-NA (mm)	3.76	4.15	6.09	2.55	2.43	2.23	*			*
6. U1-NA (°)	24.7	10.1	26.5	7.66	16.0	5.83	*			*
Mandibular skeletal measurements										
7.SNB	74.8	3.95	74.2	3.30	76.3	3.47				
8.Cd-Gn	117.5	6.68	110.2	3.63	111.3	5.43	*	*	*	
9.Cd-Go	58.2	4.06	55.5	3.65	54.5	4.60				
10.Go-Gn	77.1	6.23	72.1	2.53	71.9	4.07	*	*	*	
11.N-Me	128.3	10.1	118.5	7.72	119.9	4.70	*	*	*	
12.S-Go	81.3	5.44	76.79	5.00	75.8	7.67				
13.B-Vert	73.6	7.25	66.9	5.65	75.3	6.03	*			*
14.Pog-Vert	76.4	7.89	68.8	6.24	76.9	6.16	*	*		*
15.Go-Vert	1.88	2.37	-1.25	6.41	6.29	3.99	**			**
16.Cd-Vert	-10.1	2.30	-12.3	3.17	-9.18	2.92				
17.Cd-Hor	-8.93	2.22	-10.3	3.26	-6.82	2.57	*			*
18.B-Hor	85.1	5.23	77.7	5.62	74.4	5.76	***	***	***	
19.Pog-Hor	100.3	5.34	94.8	6.40	92.5	5.77	*		*	
20.Go-Hor	81.3	5.41	76.5	4.99	75.4	7.80				
Mandibular dentoalveolar measurements										
21.L1-NB (mm)	7.26	2.84	5.23	1.87	6.39	1.66				
22.L1-NB (°)	29.4	5.42	25.8	4.42	32.8	5.83	*			*
Maxillo-mandibular relations										
23.ANB	6.84	1.56	5.45	1.60	5.12	1.26	*		*	
24.WITTS	7.04	3.55	6.15	2.90	1.86	2.66	**		**	**
25.SN/MP	34.53	7.15	32.7	5.82	35.7	7.16				
26.Overbite	3.66	2.26	5.44	2.87	2.72	1.75	*			*
27.Overjet	7.21	2.38	8.59	3.46	3.80	1.00	***		***	***
28.Cd-A	92.7	5.05	87.69	2.53	87.7	3.50	**	**	**	
29.ANS-Me	73.3	7.33	66.3	5.67	66.9	4.38	*	*	*	
Soft tissue measurements										
30.UL-Steiner	0.87	2.27	1.67	2.58	0.30	1.41				
31.LL-Steiner	2.17	2.67	0.74	2.87	1.31	2.34				

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$
X, Mean; SD, Standard Deviation

Table III. The comparison of the cephalometric changes before and after treatment/observation period, by Analysis of Variance (ANOVA) and Duncan tests. Paired *t*-tests were performed to analyse changes within the groups.

Parameters	TFBC		Activator		Control		Test	TFBC-Activator	TFBC – Control	Activator-Control
	D	± SD	D	± SD	D	± SD				
Maxillary skeletal measurements										
1. SNA	-0.36	0.37	0.62	0.41	0.52++	0.24				
2. N-ANS	0.56	0.28	1.39	0.36	0.98	0.31				
3. A-Vert	0.76	0.40	0.79	0.41	0.81*	0.27				
4. A-Hor	3.01**	0.36	2.98***	0.52	2.32**	0.59				
Maxillary dentoalveolar measurements										
5. U1-NA (mm)	-0.26	1.20	-2.00*	0.62	0.51*	0.19				
6. U1-NA (°)	-0.10	3.10	-6.19***	1.89	0.82	0.61	++			++
Mandibular skeletal measurements										
7.SNB	0.93	0.49	2.04**	0.57	0.79	0.46				
8.Cd-Gn	3.72***	0.75	6.64***	0.69	2.78**	0.70	***	***		***
9.Cd-Go	0.30	1.13	4.86***	0.53	2.59***	0.51	***	***		
10.Go-Gn	1.84+	0.84	2.57***	0.46	1.41***	0.22				
11.N-Me	2.58	1.26	5.98***	0.72	2.80**	0.80	*	*		*
12.S-Go	2.10	1.06	5.66***	0.53	4.20***	0.44	**	**		
13.B-Vert	2.98*	0.67	2.74*	1.03	0.91	0.77				
14.Pog-Vert	3.05**	0.48	2.56*	1.10	1.04	0.83				
15.Go-Vert	0.89	0.62	0.45	0.88	-0.50	0.66				
16.Cd-Vert	-0.16	0.23	-0.56	0.52	-0.63	0.55				
17.B-Hor	3.05**	0.90	6.95***	0.83	3.18**	0.90	***	***		***
18.Pog-Hor	3.45**	0.80	7.59***	1.12	3.37**	0.98	***	***		***
19.Go-Hor	4.05***	0.90	5.68***	0.56	4.26***	0.45	**	**		**
20.Cd-Hor	0.25	0.55	0.59	0.52	0.23	0.51				
Mandibular dentoalveolar measurements										
21.L1-NB (mm)	2.70*	0.70	1.83**	0.46	0.35	0.17	**		**	
22.L1-NB (°)	5.50*	1.90	4.78**	1.50	0.97	0.66				
Maxillo-mandibular relations										
23.ANB	-1.29*	0.49	-1.41*	0.48	-0.27	0.27				
24.WITTS	-2.94**	0.53	-1.95	0.83	-0.10	0.58	**		**	
25.SN/MP	-0.29	0.49	-0.51	0.48	-1.61*	0.57				
26.Overbite	-2.69*	1.02	-3.21***	0.62	-0.46	0.44	*			*
27.Overjet	-4.69**	1.22	-5.55***	0.94	-0.15	0.27	***		***	***
28.Cd-A	-1.11	0.66	1.79*	0.60	1.56*	0.61	**	**	**	
29.ANS-Me	1.81	1.05	4.08***	0.61	1.59*	0.70				
Soft tissue measurements										
30.UL-Steiner	-1.02*	0.38	-1.34*	0.42	-0.41	0.63				
31.LL-Steiner	-0.10	0.50	0.66	0.59	-0.67	0.45				

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; +, $p = 0.056$; ++, $p = 0.058$
D, means of differences; SD, standard error of the differences

and significantly greater compared with the untreated controls ($p < 0.01$).

Discussion

The present study is the first to compare a contemporary fixed-functional appliance, TFBC, with a conventional removable functional appliance, the Activator. A Control Group was included in order to discount the effects of normal growth changes given the length of treatment time experienced by the Activator Group. The data for the Control Group was selected from the archives of the University of Ankara which was collected between 1991 and 1996. At the time of data collection, all parents and patients agreed to participate and signed informed consent.

Both appliances were successful in treating the Class II relationship with varying degrees of skeletal and dental change. In line with the shorter treatment times associated with fixed-functional appliances when compared with removable appliances,[18-21] the treatment period was shorter for the TFBC Group. Previously published case studies advocated that the TFBC be used for three months, which provided the rationale for the period of treatment followed in the present study.[10-16]

Maxillary changes were similar and, in general, minor for both treatment groups, although a slight but insignificant decrease in the SNA angle was observed in the TFBC Group. Other studies utilising fixed-functional appliances applied longer treatment periods, with correspondingly greater than expected reductions in maxillary growth.[20-22] The findings regarding the Activator Group were consistent with previous studies which showed removable functional appliances had little or no significant effect on maxillary structures,[23-27] which conflicted with earlier reports showing maxillary growth inhibition.[1,28]

There are conflicting reports on the mandibular effects of functional appliances.[29,30] Although several clinical studies have reported that removable functional appliances produce effects which are mostly dento-alveolar and do not differ from what could be attributed to normal growth,[22,29,30] additional studies have reported skeletal and dental improvements in the correction of Class II malocclusions.[31-33] The Activator Group in the present study showed significant improvements in mandibular skeletal measurements, similar to those in previous reports which examined removable functional appliances.[27,31-33] Although the TFBC Group showed fewer mandibular skeletal changes than the Activator Group, the magnitude of the changes was still greater than in the Control Group. It should also be noted that, at the beginning of the treatment/observation period, the skeletal values were already higher in the TFBC group, which may be due to the slightly increased age of the TFBC patients. This in turn might be the reason for fewer mandibular changes in the TFBC group.

Cozza et al. reported that, even though the Twin Block appliance generated a greater increase in mandibular length (3.4 mm) compared with the Herbst appliance (3.0 mm), the Herbst appliance was more efficient in treating a Class II malocclusion due its fixed nature and the shorter treatment duration.[5,33] The increased efficiency of the Herbst appliance could also be due to its use over a longer historic period and also its more robust nature when compared with the TFBC. The improvement in the Class II relationship in the TFBC Group in the present study was due to mandibular skeletal and dentoalveolar changes. The observed increase in effective mandibular length was almost half that seen in the Activator Group. This could be attributed to the shorter treatment duration as well as the increased pretreatment age of the patients in the TFBC Group.

As suggested by Björk,[34] and consistent with earlier studies,[11,35-37] an anterior rotation of the mandible was observed in both treatment groups as well as in the Control Group. The mandibular plane angle (SN/MP) decreased slightly in all groups, although not significantly. This decrease may have been the result of balancing increases in posterior facial height (S-Go) and/or ramus height (Cd-Go). The clinically and statistically significant increase in posterior facial height in the Activator Group was the result of the vertical activation in the construction bite and the delayed trimming of the acrylic covering the posterior occlusal surface after the Class I relationship has been achieved.

As previous studies have shown, functional appliances, whether removable or fixed, will also have effects on dentoalveolar structures.[23,38,39] In the present study, overjet and overbite were significantly reduced in both treatment groups, with mandibular incisor proclination and maxillary incisor retrusion contributing to these results. The limited retrusion of the upper incisors in the TFBC Group may be attributed to upper palatal

root torque applied by the fixed appliances and the shorter treatment time for this group when compared with the Activator Group.[20,23] Even without the use of transpalatal arches in the TFBC patients, no buccal tipping of the upper molars was observed.

The factors governing the success or failure of functional appliance treatment are still controversial.[40] Besides patient cooperation, the most important factor determining success may be timing. In the present study, the mean chronological age of the TFBC Group was slightly higher than that of the Activator Group, as the full permanent dentition is required for TFBC application. This may have been a factor in the smaller increases seen in mandibular length in the TFBC Group. Ruf and Pancherz[41] reported Herbst treatment was an effective method for remodelling the condyle and glenoid fossa in young adult Class II patients. According to a study by Kim and Nielsen,[42] the growth intensity of the mandibular condyle in untreated subjects with Class II malocclusions varied considerably between subjects and within subjects from year to year. The findings indicated that some subjects could have as little as 1 mm of condylar growth over a year, whereas others could have as much as 8 mm, irrespective of age.

A major limitation of this comparative study was the small sample size and short observation period. Therefore, these limitations will be addressed in future studies.

Conclusion

The TFBC and the Activator were both successful in correcting a Class II relationship in young adults, with greater skeletal mandibular changes identified in the Activator Group and mandibular dentoalveolar changes in the Twin-Force Bite Corrector Group. The overall treatment period was significantly shorter in the TFBC Group and this raises questions regarding the long-term stability of the mandibular changes, which require further evaluation.

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